REINFORCE

REsearch INfrastructures FOR Citizens in Europe

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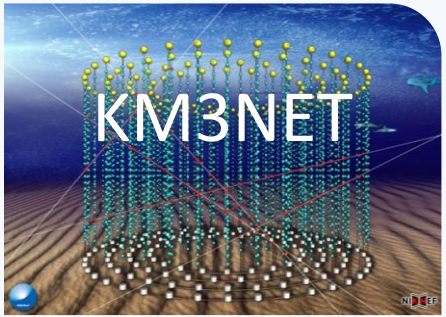
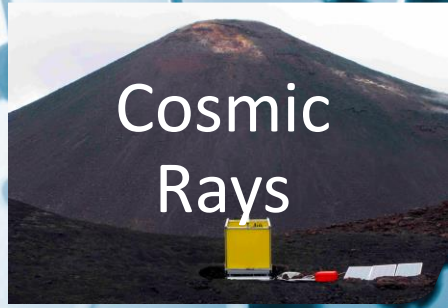
(Research Infrastructures FOR Citizens in Europe)

1 December 2019 – 1 December 2022





16 October 2020

S. Katsanevas, EGO Director

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GOALS

Develop

1. *Interdisciplinary scientific knowledge with the support of citizens in a two way process. Associate research on "fundamental science" with environmental concerns*
2. *Multi-sensorial "multi-messenger" understanding of the cosmos .Go beyond the Visual*
3. *Inclusion and diversity . Treat gender issues. Extend participation to visually impaired, confined, seniors*
4. *Critical thinking in a world of increased digital connectivity . Effectively separate signal from background noise, formulate hypotheses, estimate proper biases, manage uncertainty, collective thinking versus herd thinking,…*
5. *Paths traversing traditional frontiers of the modes of apprehension of reality . E.g. the cognitive and the affective: Art and Science*

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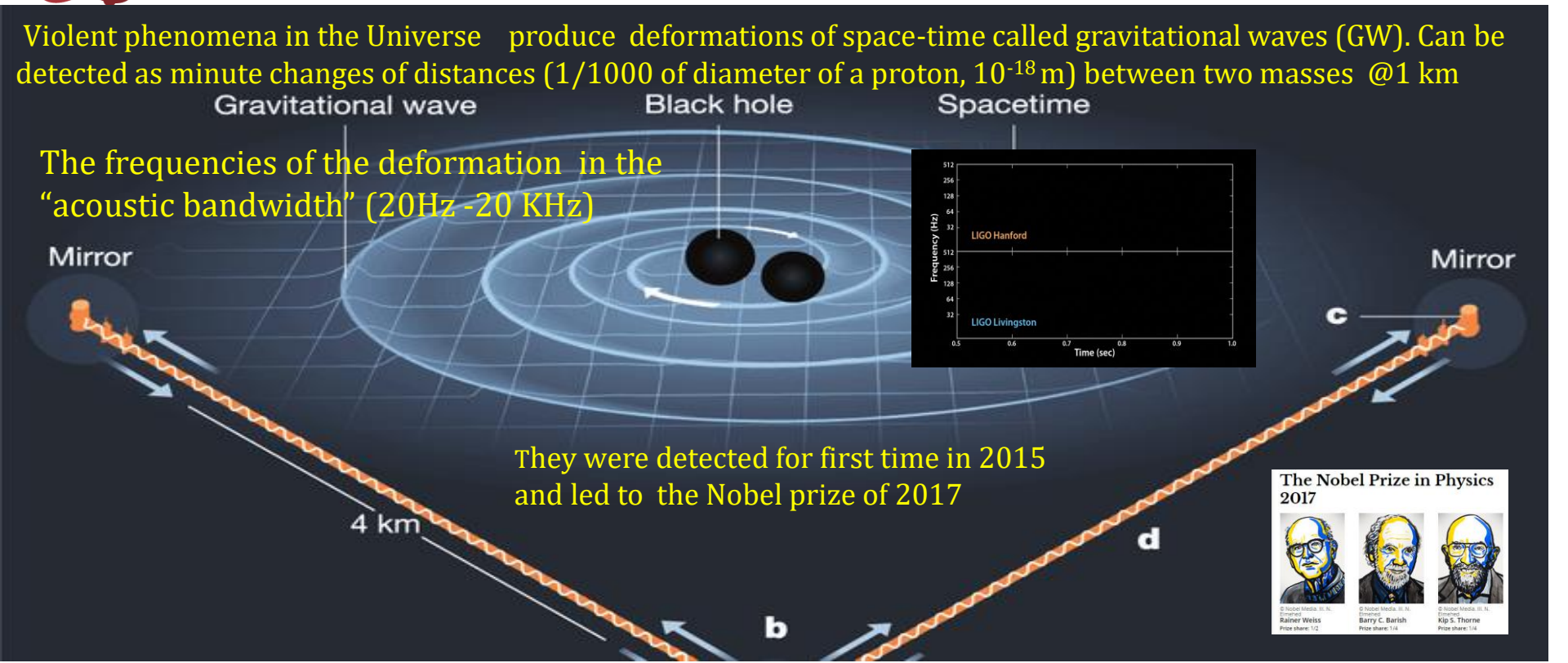
Example 1: Gravitational Waves Virgo/EGO

Violent phenomena in the Universe produce deformations of space-time called gravitational waves (GW). Can be detected as minute changes of distances (1/1000 of diameter of a proton, 10^{-18} m) between two masses @1 km



The frequencies of the deformation in the "acoustic bandwidth" (20Hz -20 KHz)

They were detected for first time in 2015 and led to the Nobel prize of 2017

Today we detect one event per week in a truly global network of detectors (US, Europe, Japan) working as a single system (triangulation and analysis)

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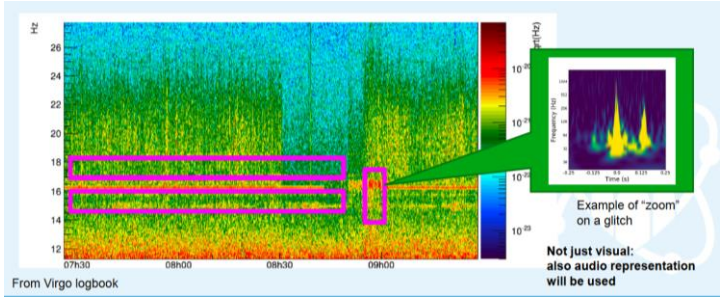
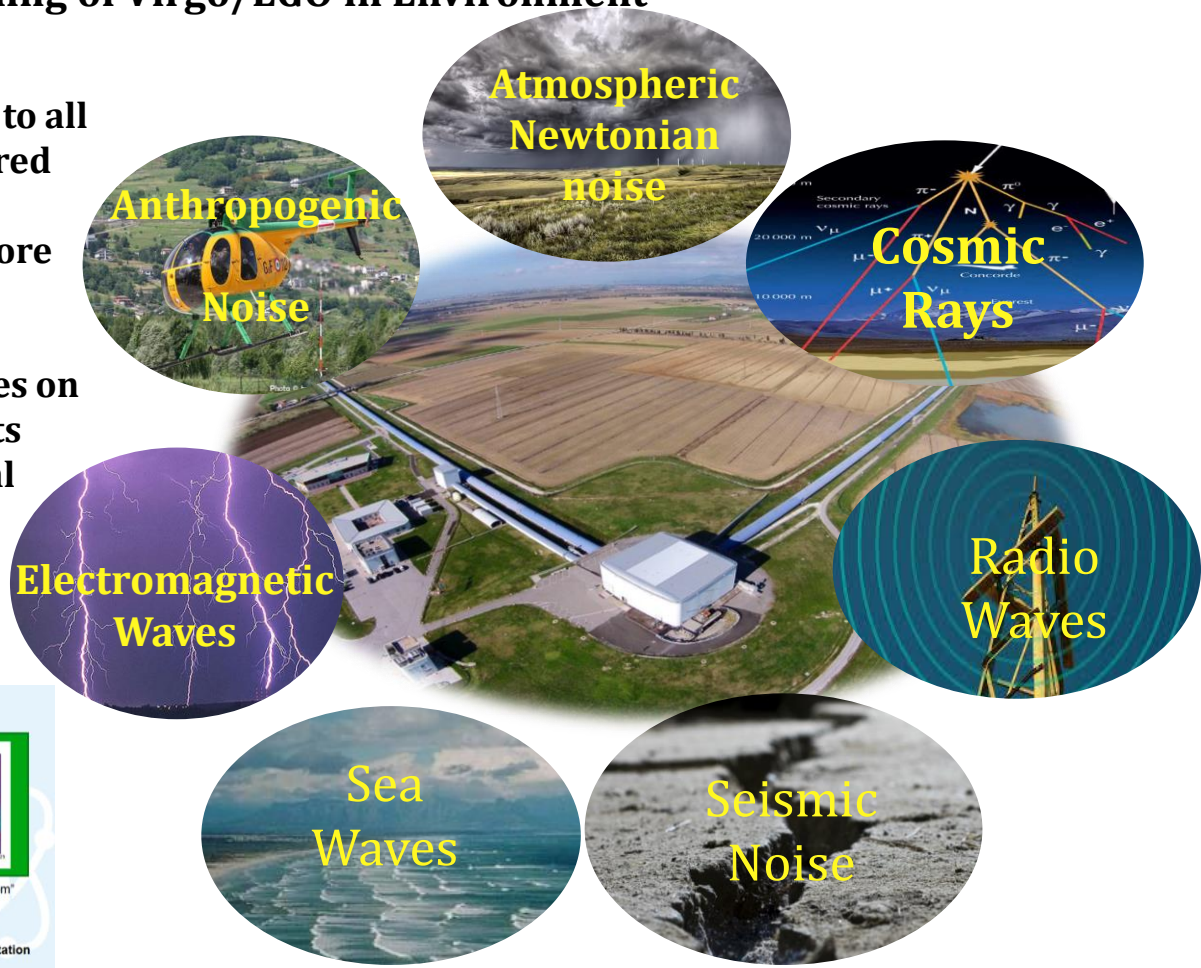
Imbedding of Virgo/EGO in Environment

- **Virgo: A laser interferometer sensitive to all influences of the environment. Monitored with 2500 “slow sensors”**
- **Need to understand the Geosphere before understanding the Universe**
- **Collaboration with Geoscientists (seismicity), Ecologists (impact of waves on coastal erosion), Atmospheric scientists (clouds and newtonian noise), Regional instances on Anthropogenic noise.**
- **Citizen Science task: classify and characterise signals and “noise” depending on the point of view**





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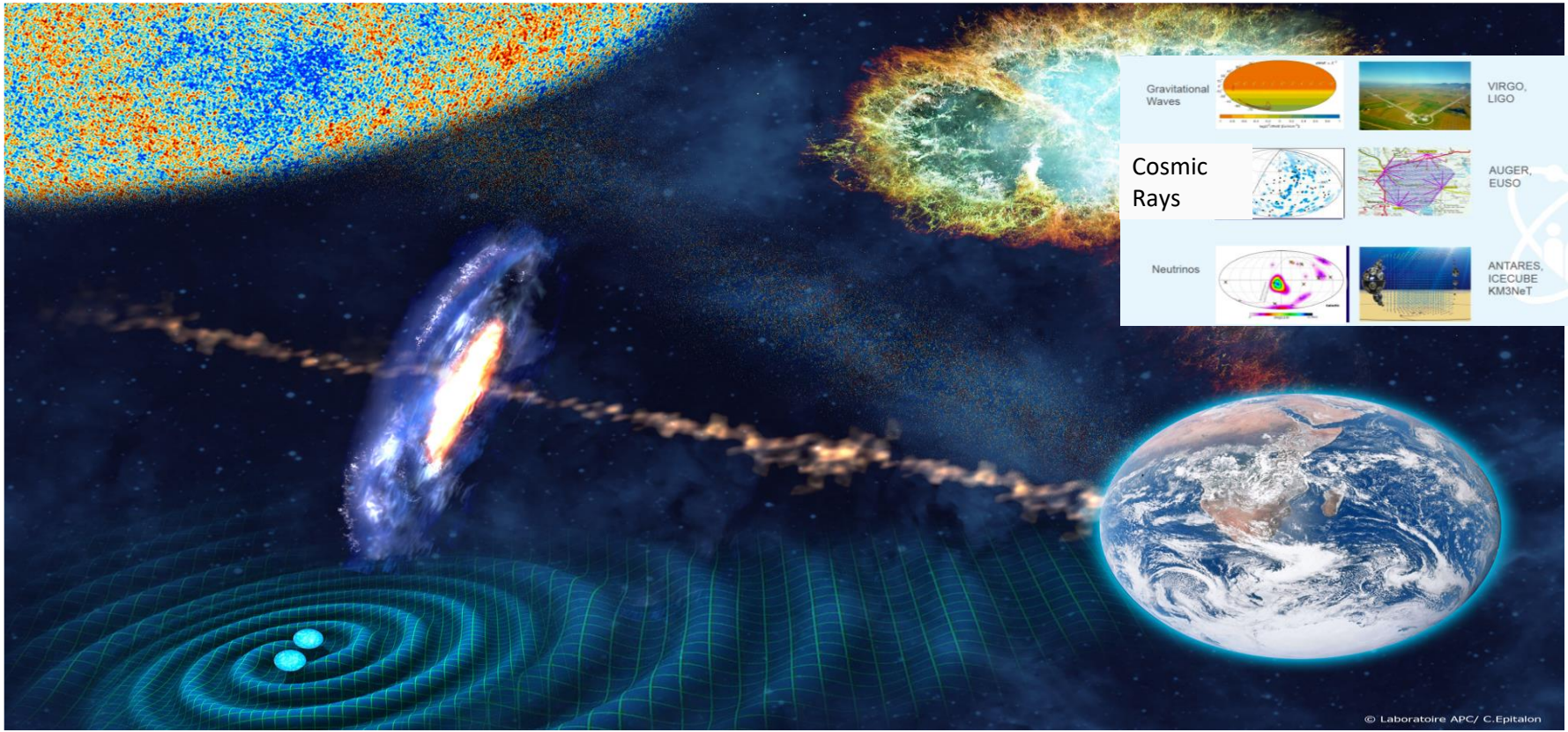
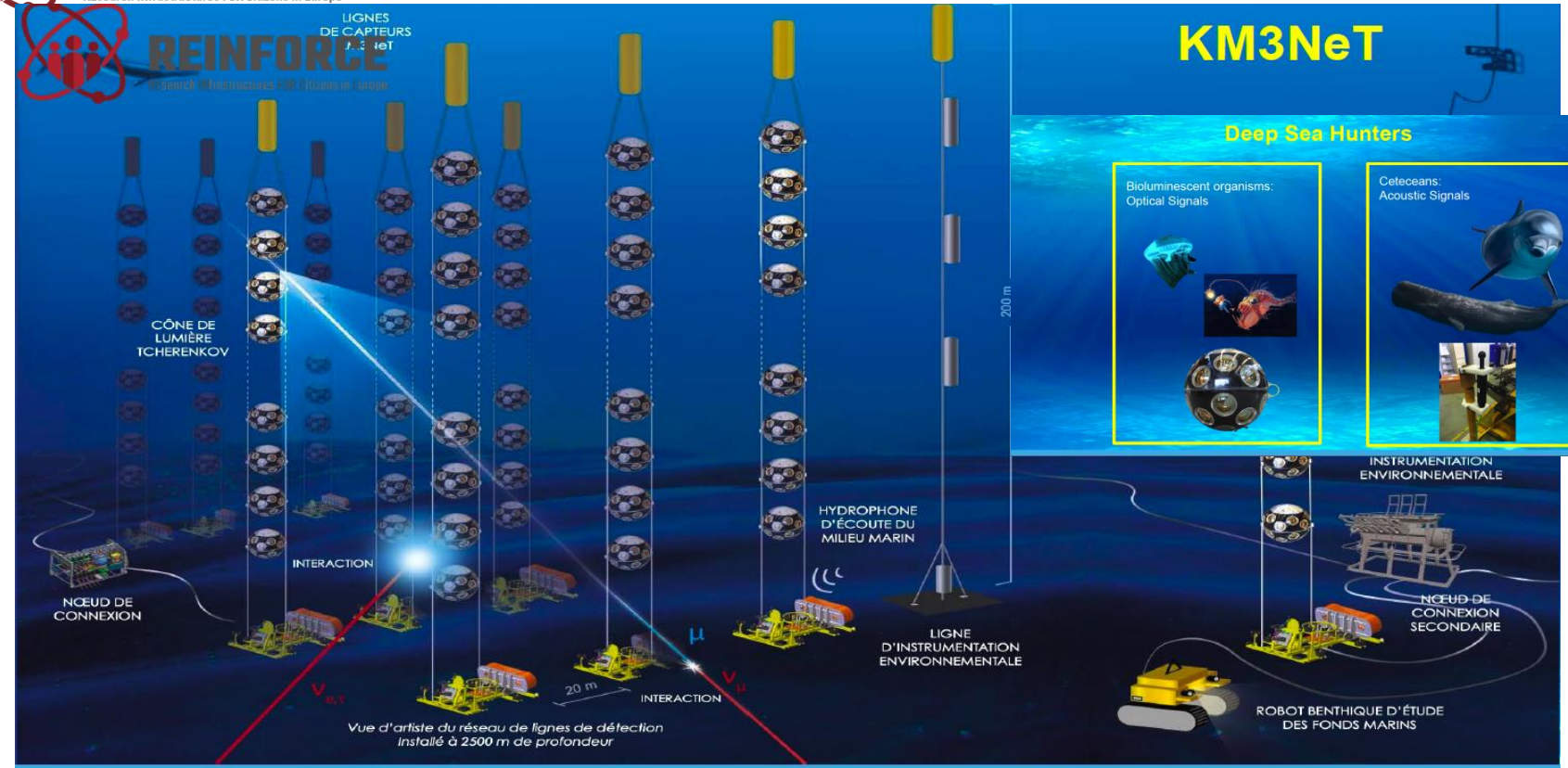
New ways to sense the Universe: Multi-messenger Astrophysics



Example 2: Imbedding Deep sea Neutrino Observatories in the Biosphere



Vue d'artiste du réseau de lignes de détection installé à 2500 m de profondeur

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Example 3: Cosmic Rays and Muography

Muography = **μ**-ray imaging technique : absorption / scattering → sensitive to **ϱ** (opacity)

Geosciences

- Volcanology
- Geology
- Hydrology
- Atmosphere physics
- CR physics
- ...

cnrs INSU Observer & comprendre

Archaeology

- Tumulus
- Anthropic structures
- Ruins
-

Industrial controls

- Non invasive controls
- Nuclear cycle production
- Civil engineering
- Tunnel boring machines
- Prospection & mining
- ...

Technological transfer

Cosmic Rays
also a climate index

Methodology and Tools

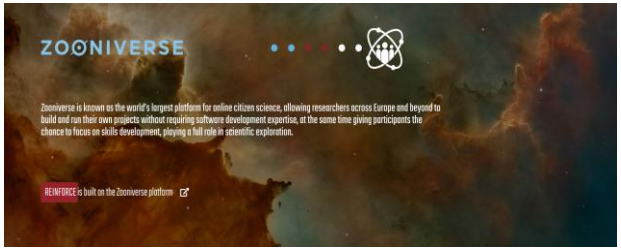
METHODOLOGY:

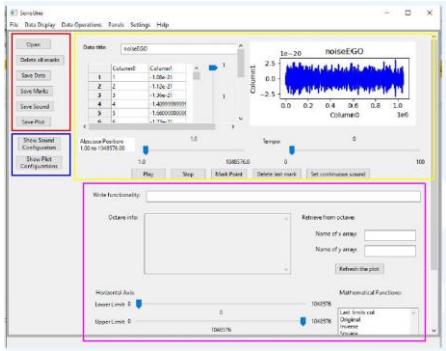
1. *Engage citizens in frontier research*
2. *Develop Large Scale Citizen Science Demonstrators*
3. *Implement a participatory engagement design*
4. *Develop a Policy Roadmap*

TOOLS:

1. *Use a common platform Zooniverse (Citizen Science Platform with more than 1,000,000 volunteers)*
   - *www.zooniverse.org*

2. *New sonification software (SonoUno)*
   1. *https://pypi.org/project/sonoUno/*





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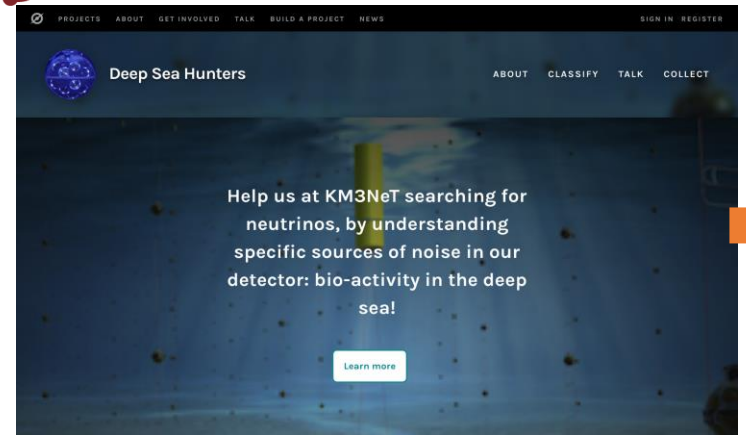
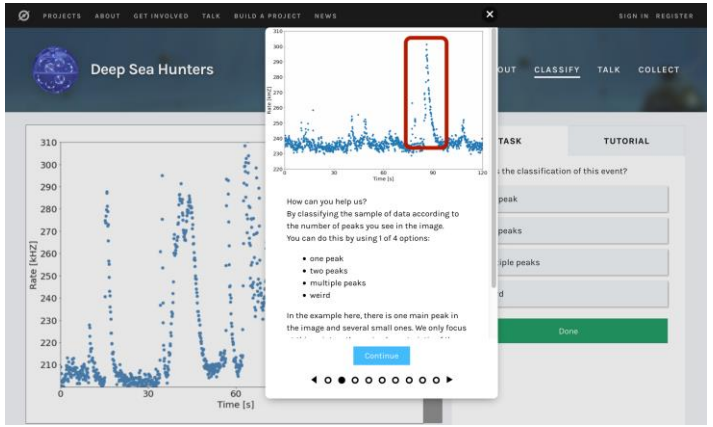
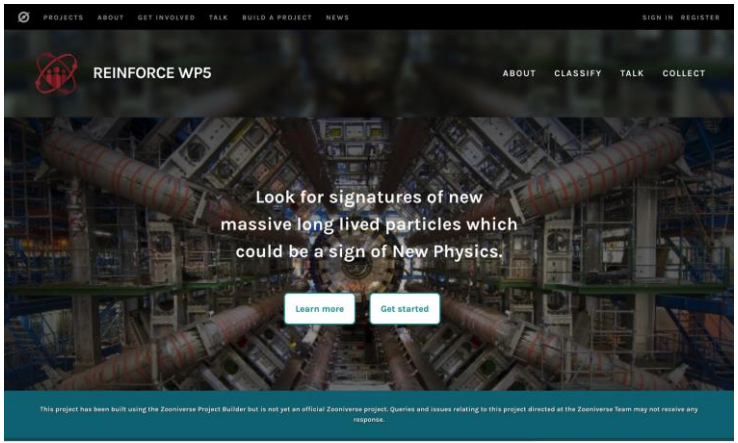
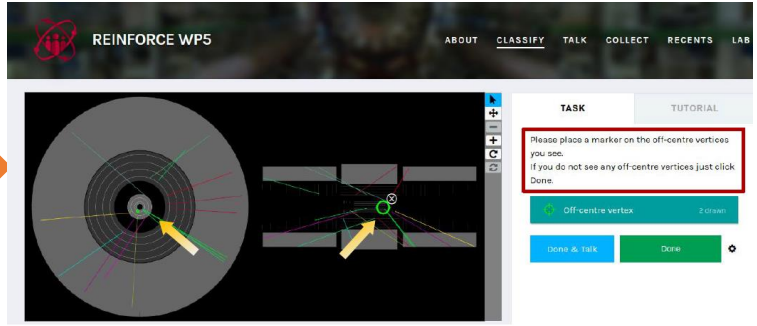
A common platform ZOONIVERSE









ZOONIVERSE uses images to display collision events and provides a tool set for users to make their selections.

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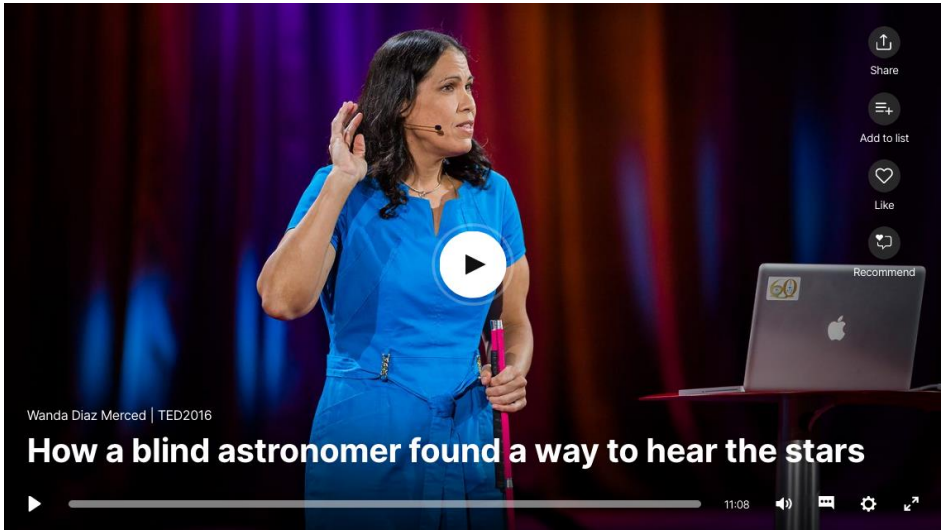
An important tool : Sonification

- Not only increasing inclusion . Also increasing the researchers discrimination power of signal over background through the use of sound.

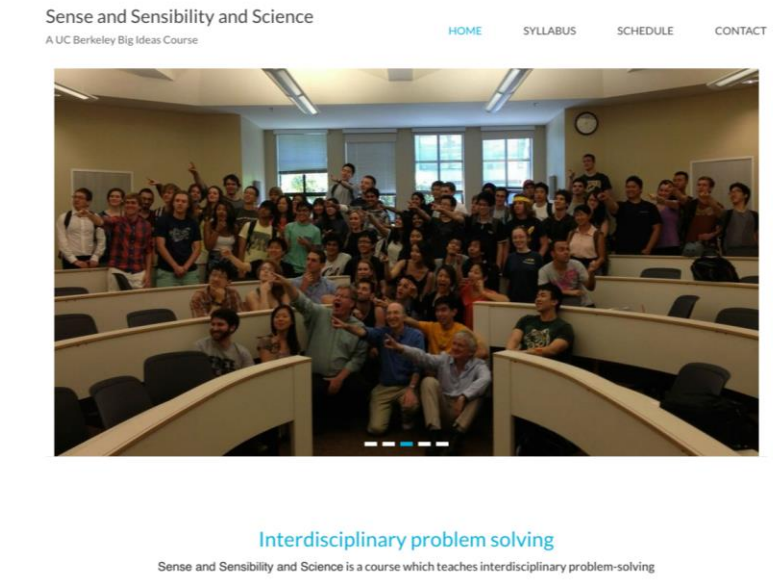


Work by Wanda Merced-Diaz and Beatrice Garcia

https://www.ted.com/talks/wanda_diaz_merced_how_a_blind_astronomer_found_a_way_to_hear_the_stars?referrer=playlist-ted_deep_cuts_vol_2&language=en

Last but not least
Critical Thinking and Art & Science

- Develop in parallel, critical sense, through discussions hangouts, sprints etc
- Collaboration in progress with Sense and Sensibility in Science, Big ideas course of S.Perlmutter , Berkeley
- Co-create events with artists , e.g. exhibition The Rhythm of Space, co-founded with Foundation Carasso, and participation of key artists



http://sensesensibilityscience.com/

https://sites.ego-gw.eu/ilritmodellospazio/

A poem by AIMA people seeing a work of art on black holes :

Riflessione:
Nucleo sferico, globo, forma.
Nero. Terra notturna illuminata dalla luna.
Abisso.
Pieno o vuoto…
...liscio!
Mistero esoterico.
Ragione. Emozione.
Inquietudine. Oppressione.
….freddo!
Pupilla di Polifemo.

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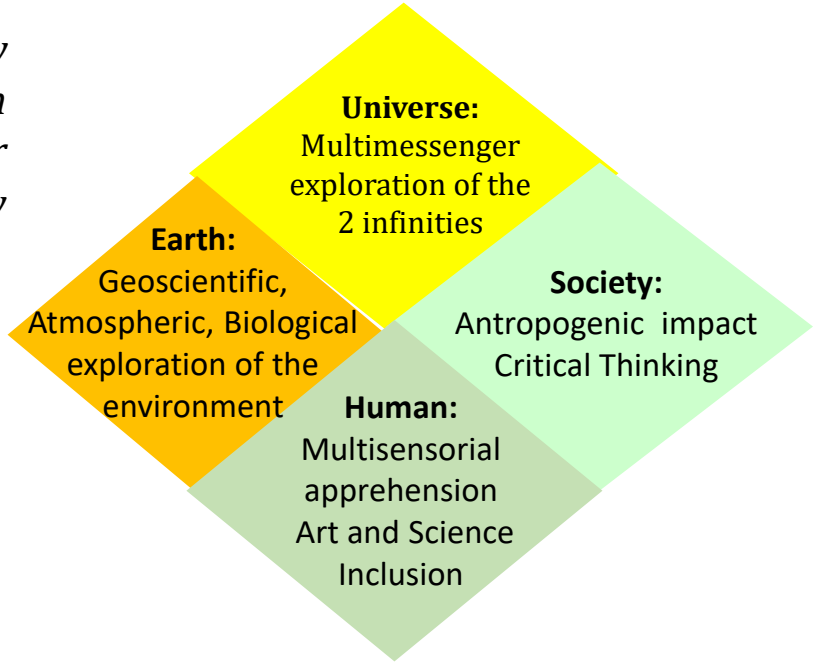
Conclusion

REINFORCE perceives citizen science as a participatory process, in which citizens are trained in frontier science in constant connection with researchers through their communities of practice, they provide their feedback, they voice their concerns and

- *explore the boundaries of knowledge.*
- *explore multi-modal apprehensions of reality (image, sound,…) and therefore tackle inclusion and diversity issues*
- *forge interdisciplinary connections studying the embedding of large infrastructures in the environment*
- *support critical thinking and art/science activities at the interface of research and society*

In short invent new ways of understanding of our embedding in the Cosmos, where cosmos here denotes beyond the Universe, Earth, Society and the Human



The four Cosmos